



Bayesian ^{14}C analysis, formation processes, and accumulation rates of the Prisoners Harbor shell midden and village complex, Santa Cruz Island, California



Nicholas P. Jew ^{a,*}, Torben C. Rick ^b, Michael A. Glassow ^c, Jeanne E. Arnold ^d

^a Department of Anthropology, University of Oregon, United States

^b Program in Human Ecology and Archaeobiology, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, United States

^c Department of Anthropology, University of California, Santa Barbara, United States

^d Department of Anthropology, University of California, Los Angeles, United States

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ABSTRACT

The Prisoners Harbor site (CA-SCRI-240), one of the largest sites on California's Channel Islands and the likely location of the Chumash village *Xaxas*, played a key role in regional models of emergent complexity and culture contact. Despite substantial excavation at the site, published research has focused on the most recent 500 years of the site's occupation, with comparatively little attention given to the 2–3 millennia preceding this. Here we focus on the formation and chronology of CA-SCRI-240 by presenting a Bayesian analysis of 36 radiocarbon dates from throughout the site's occupation. Comparing three suites of radiocarbon dates, we provide a revised chronology for CA-SCRI-240 and examine site formation processes, sediment deposition rates, and the implications our study holds for reconciling older radiometric dates with large analytical errors and higher precision accelerator mass spectrometry dates. Our analysis suggests that the earliest site occupation was 2750 cal BP, roughly 2000 years later than previously presumed. Sedimentation rates vary throughout the 5.7 m sequence. Deposits for the first 1000 years accumulated slowly followed by relative increase in accumulation rates in the uppermost occupation levels dating to historic times. Our study demonstrates the importance of Bayesian analysis for improving radiocarbon chronologies for large, multi-component sites.

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1. Introduction

Coastal archaeologists have long been interested in understanding the formation and accumulation of shell middens, with such studies having important implications for broader interpretations of site function and human cultural and environmental developments (see Claassen, 1998; Roksandic et al., 2014; Stein, 1992; Waselkov, 1987). A key component of this research is chronology building, especially the use of radiocarbon (^{14}C) dating, to place site formation and human cultural issues in proper chronological context. In recent years, Bayesian analysis of ^{14}C dates has emerged as an important tool for providing statistical support for the reliability of site chronologies and documenting the presence of outliers or problematic dates (Bayliss and Bronk Ramsey, 2004; Bronk Ramsey, 2009a,b). Bayesian ^{14}C analysis has become a potent tool for researchers working at deeply stratified sites, including shell middens, where ^{14}C dates can be compared to stratigraphic excavation data (see Culleton et al., 2012; Jazwa et al., 2013; Kennett et al., 2011, 2014).

In this paper, we use Bayesian analysis of radiometric and high-precision AMS ^{14}C dates to evaluate the formation and chronology of the Prisoners Harbor site (CA-SCRI-240) on Santa Cruz Island, California (Fig. 1). The Prisoners Harbor site is the probable location of the Chumash village of *Xaxas* and is one of the most significant sites on the Channel Islands. It has been of scientific interest since at least the 1920s (see Arnold, 1994, 2001; Noah, 2005), producing thousands of artifacts and providing information about Chumash lifeways both before and after contact with Europeans. The site is thought to have been home to island elites, used as a trade hub throughout prehistory, and the location of significant production of chert microliths (see Arnold, 1987). For decades, the site has helped researchers investigate a variety of issues of broad anthropological significance, including emergent sociopolitical complexity, bead manufacture, lithic technologies, subsistence economies, and island settlement patterns (e.g., Arnold, 1983, 1994, 2001; Colten, 1995, 2002; Colten and Arnold, 1998; Kennett, 2005; Noah, 2005; Rick et al., 2005).

Despite significant research at the site, especially by Glassow and Spaulding in the 1970s and by Arnold in the 1990s (see Arnold, 2001), a comprehensive assessment of the site's ^{14}C sequence has never been published. This has created some confusion about the site's antiquity and timespan of occupation. In a review of Channel Islands archaeology, for instance, Rick et al. (2005:202) report that the Late Holocene

* Corresponding author.

E-mail addresses: njew@uoregon.edu (N.P. Jew), rickt@si.edu (T.C. Rick), glassow@anth.ucsb.edu (M.A. Glassow), jeanarnold@ucla.edu (J.E. Arnold).

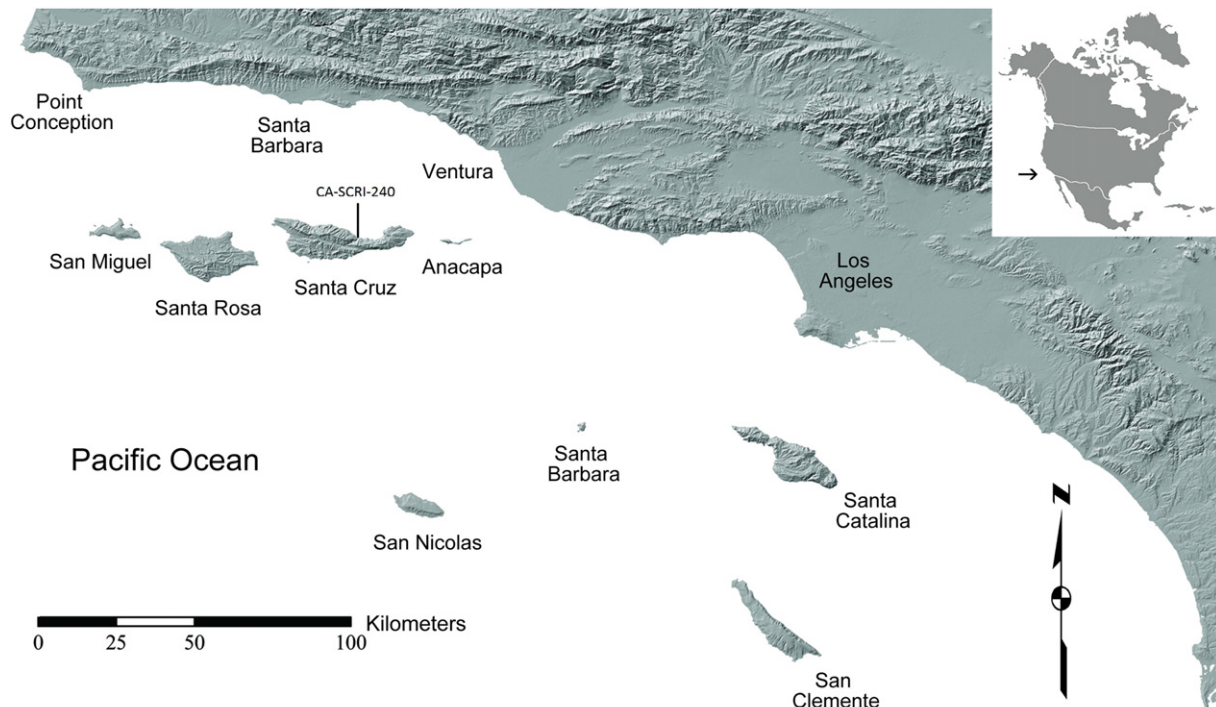


Fig. 1. Map of California's Channel Islands including the location of CA-SCRI-240.

occupation of the site may have begun around ~3210 cal BP, and Kennett (2005:160–167) similarly suggested an occupation beginning around ~3151 cal BP. Drawing on a single radiometric ^{14}C date obtained in the 1970s, Braje et al. (2011:283) suggested the site occupation may have begun some 5300 years ago. Colten and Arnold (1998: 686–687) describe one of the only attempts to construct a site chronology, conducted by Phillip Walker in the 1990s. He compared reported ^{14}C dates with diagnostic artifacts recovered from the site along with stratigraphic profile drawings to generate a chronology for the upper deposits of the site. This basic chronology encompassed three periods between approximately AD 1000 and 1815. Because of the lack of published research on the site's chronology, questions remain about when human occupation of the site began, how the early occupation of the site compares to later occupations, and how the site's ^{14}C dates can inform site formation.

To resolve these issues, we present an analysis of all ^{14}C dates ($n = 36$) from the site, including 21 dates obtained in the 1970s (Taylor, 1975:398–340) and 16 new Accelerator Mass Spectrometry (AMS) high-precision dates from the base of the site deposits to the uppermost deposits during the Historic period. The site includes 50 well-defined strata that provide the stratigraphic details for building the Bayesian radiocarbon model and evaluating the dates obtained in the 1970s and 2010s. Our analysis has implications for chronology building in shell middens and other deeply stratified sites and for reconciling differences between different sets of radiometric and AMS ^{14}C dates often obtained decades apart.

2. Environmental and cultural background

1. The Northern Channel Islands and the Prisoners Harbor site

The Northern Channel Islands are located in the Santa Barbara Channel region off the coast of southern California and consist of Anacapa, Santa Cruz, Santa Rosa, and San Miguel islands. The islands are home to highly productive marine ecosystems that contain a variety of shellfish, fish, pinnipeds, seabirds, kelp, and other nearshore and marine resources (see Rick et al., 2005: 173). Freshwater, lithic outcrops, and

animal and plant resources vary between islands, with the greatest diversity found on the larger islands of Santa Cruz and Santa Rosa (Jazwa and Perry, 2013b; Rick et al., 2005).

Santa Cruz is the largest island in the chain at 249 km², has the greatest variety of terrestrial resources, and contains the most abundant perennial streams and springs (Jazwa and Perry, 2013a:9; Junak et al., 1995). The island is ~30 km from the mainland and possesses 480 native plant taxa and about a dozen small terrestrial mammals, including the island fox (*Urocyon littoralis*) and island spotted skunk (*Spilogale gracilis amphiala*; Junak et al., 1995; Schoenherr et al., 1999). Santa Cruz Island's interior and coastal environmental diversity helped foster a variety of different human land use strategies and ultimately archaeological site types, including villages with permanent house structures (see Glassow et al., 2010:11.3).

CA-SCRI-240 is located at Prisoners Harbor on northeastern Santa Cruz Island at the mouth of Cañada del Puerto, which extends into the island's large interior valley. Prisoners Harbor is a relatively sheltered anchorage, and a sandy beach is located approximately 50 m beyond the northern edge of the site. A freshwater stream forms a wetland adjacent to the site, but the stream was repositioned in the late 19th century, destroying a large section of the site. Rogers (1929) could still see portions of the site immediately following stream erosion and he suggested that the site may have originally been 120 m (east-west) × 46 m (north-south). Arnold (1994) noted that in the early 1990s the site measured about 40 × 45 m, having lost about 80 m on its eastern end. Expansion of the wetland was recently part of a major restoration project undertaken by the National Park Service.

CA-SCRI-240 is one of the largest sites on California's Channel Islands, with deposits extending to a depth of ~5.7 m (Fig. 2, see Arnold, 2001). In his 1974 stratigraphic notes, Spaulding distinguishes between two principal stratigraphic units: an upper unit "heavy in shell as opposed to earth and stone" and nearly a meter thick but becoming thinner toward the site margins, and a lower unit with "dark earth as its major component." The matrix of the habitation deposits appears to be sand and silt blown in from the beach located north of the mound. The lowermost deposits contain alluvial deposits from the stream descending to Prisoners Harbor through Cañada del Puerto.

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